



3.0 Progress Toward Eliminating Infiltration

As described in the first and second Progress Reports, based on the initial phases of sewer system characterization in 2008 and 2009, the City was able to confirm that there are several sub-basins in its collection system with high levels of RDII.

With regard to location of infiltration sources, the City has, for many years, had an aggressive CCTV program that televised thousands of feet of City sewer lines. In 2009, 63,864 feet were inspected and during 2010, 30,259 feet were inspected. As described in the Progress Report dated July 28, 2011, issues with the CCTV equipment in the first half of 2011 resulted in a reduced rate of inspection; 3,865 feet. As described in the Progress Report dated January 27, 2012, 9,622 feet were inspected in the second half of 2011. As described in the Progress Report dated January 28, 2013, 20,224 feet were inspected in 2012. As described in the Progress Report Dated July 30, 2013, 13,977 feet were inspected in the first half of 2013. As described in the Progress Report dated February 25, 2014, 20,444 linear feet were inspected in the second half of 2013, bringing the total for 2013 to 34,421 feet. The quarterly CCTV inspection lengths, logs and ratings for the first half of 2014 were presented in individual spreadsheets in Appendix A of AO Progress Report No. 10, indicating a total of 49,695 linear feet inspected in the first half of 2014. The quarterly CCTV inspection lengths, logs and ratings for the 3rd and 4th quarters of 2014 were presented in Appendix A of AO Progress Report No. 11 which indicated that 24,723 linear feet were inspected in the 3rd quarter and 14,518 linear feet were inspected in the fourth quarter of 2014. The resulting total linear feet inspected in 2014 was 88,936. The quarterly CCTV inspection lengths, logs and rating for the 1st and 2nd quarters of 2015 were presented in Appendix A of AO Progress Report 12 which indicate that 12,186 linear feet were inspected in the 1st Quarter and 14,988 in the second quarter, resulting in a total of 27,174 feet inspected in the first half of 2015. The quarterly CCTV inspection lengths, logs and rating for the 3rd and 4th quarters of 2015 were presented in Appendix A of AO Progress Report 13 which indicate that 29,251 linear feet were inspected in the third quarter and 24,442 feet in the second quarter, resulting in a total of 53,693 feet inspected in the second half of 2015. The resulting total linear feet inspected in 2015 was 80,149.

The quarterly sewer system televising reports for the 1st and 2nd quarters of 2016 are presented in Appendix A of this AO Progress Report and indicate that 16,280.06 linear feet were



inspected in the first quarter and 15,044.07 feet in the second quarter, resulting in a total of 31,324.60 feet inspected in the first half of 2016.

A map showing the location of NAASCO-rated sanitary sewer defects based on CCTV inspection in the first half of 2016 is presented in Appendix A, and is titled *Sanitary Sewer Defects Identified through CCTV Inspections January 1 – June 30, 2016*.

In addition, and as first reported in AO Progress Report No. 11, the Sanitary Sewer Evaluation Study (SSES) of the primary and secondary basins of concern identified through modeling of the collection system was completed in the second half of 2014. The scope of work included the CCTV inspection of 102,210 linear feet of sewer, ranging in size from 8 to 36 inches; existing manhole inspections; and point repairs or cleaning as required.

As described in prior AO progress reports, the 2014 LCA Allentown Division Budget provided funding for a new CCTV truck fully equipped with the latest video pipeline inspection and assessment equipment and software. The *Allentown Water and Sewer Utility System Concession and Lease Agreement Operating Standards* require that an average minimum of 55,000 linear feet of sanitary sewer pipe be cleaned and televised on an annual basis, with additional CCTV footage in a given year being eligible for carry-over in subsequent years. The purchase of the new truck and equipment will ensure that this standard is met.

The CCTV program has been successful in locating broken pipes and other system problems, such as blockages caused by root intrusion or grease. Based on the identification of defects through the CCTV program, numerous repairs have been made.

As shown in the table of Trenchless Sewer Repairs in Appendix A of the AO Progress Report for Period 13, a total of 5 trenchless repairs were performed in 2010, 23 trenchless repairs were performed in 2011, 19 were performed in 2013, and 2 trenchless repairs were performed in 2014, and 50 trenchless repairs were performed in connection with the SSES project.

In the first half of 2015, a scope of work was developed and bids were received for the 2015 Trenchless Sanitary Sewer Point Repairs Project. A contract was executed with Video Pipe Services for this project. This work was completed in the second half of 2015. As shown in the listing of 2015 Trenchless Sewer Repairs in Appendix A of AO Progress Report 13, the total cost of this work was \$88,524.

As shown in the Sewer Line Repair Report in Appendix A of AO Progress Report 13, a total of 15 repairs by excavation were completed in 2014 via the combination of work performed



by LCA and through the SSES project. As also shown in the Sewer Line Repair Report, the total cost of sewer line repairs by excavation in 2014 was approximately \$244,071. In 2015, a total of 8 repairs were made by excavation at a total cost of \$103,165.

As shown in the Sewer Line Repair Report in Appendix A, in the first half of 2016 a total of four repairs by excavations were completed at a total cost of \$43,846.12. A map showing the location and type of sewer line repairs is presented in Appendix A and is titled *Repaired Sanitary Mains, City of Allentown Sanitary 2016*.

In addition, and as reported in prior AO Progress Reports, more than 1,200 infiltrating joints have been found sealed over the years, and many sewer blockages have been cleared by sewer jetting and other means. While the clearing of blockages has ensured that hydraulic conveyance capacity is maximized, the sealing of joints has historically not yielded a significant reduction in infiltration to date.

A summary table listing known *Sanitary Sewer Defects* is presented in Appendix A and shows the location of the defect, the NASSCO defect Type, the NASSCO Grade, type of repair considered, the repair completion date and the projected completion date for repairs not yet made.

As indicated in prior Progress Reports, some of the defects have historically been root-related. The root control work completed in the first half of 2016 is presented in the Sanitary Sewer Defects summary table in Appendix A.

Regarding defect rating, historically the City had relied on the experience and judgment of an in-house engineer with nearly 50 years of experience to determine when a defect is of sufficient magnitude to warrant repair, and to determine the appropriate method of repair. Defects significant enough to warrant a repair include broken, crushed or collapsed pipe, or large cracks, especially in the bottom half of the pipe.

In order to move toward an industry-standard approach to condition assessment and defect rating, the City provided National Association of Sewer Services Companies (NASSCO) Pipeline, Manhole and Lateral Assessment and Certification training for eleven (11) staff members of the Bureau of Water Resources on February 21st, 22nd and 23rd of 2011. Copies of the NASSCO certifications for these individuals were presented in the Progress Report dated July 28, 2011.



Immediately following the NASSCO certification training, the City began to research if the Peninsular Technologies, PipeTech Software Suite utilized on the City's CCTV inspection truck to record live video from CCTV inspection camera equipment was NASSCO compliant. The technical support staff at Peninsular indicated that their PipeTech software was the first to be certified by NASSCO for its adoption of the PACP Pipeline Assessment Standards. Operators certified by the PACP program can use the software to export data in the national standard format and the NASSCO CCTV inspection form templates are accessible with an operator certificate number issued by NASSCO.

Unfortunately, on or around March 21, 2011 the City's only CCTV truck was taken to the garage then under contract with the City to service all motor vehicles to have a mechanical problem with the differential corrected. Upon leaving the garage it was determined that the differential was installed incorrectly which snapped the drive shaft, resulting in the need for significant additional repairs. The City finally received the repaired truck on or around April 15, 2011.

A few weeks later the CCTV truck's on-board computer utilized to store the digital CCTV images of the sewer pipes inspected started to malfunction. On May 3, 2011 the computer was shipped back to Peninsular Technologies for repair. Peninsular advised the City that the existing computer was inadequate to handle the multiple applications the City was attempting to use it for, and therefore the City would need a higher capacity and faster desk-top computer to operate all programs with GIS. The City received the new computer on July 1, 2011, and subsequently installed the computer and software.

These unforeseen equipment and hardware problems resulted in a reduced rate of CCTV inspection during the first half of 2011, and delayed implementation of the use of the NASSCO CCTV inspection form templates which were unavailable in the PipeTech Software Suite until the City obtained NASSCO certification. The City's Water Resources staff debugged the new computer hardware and learned to use the new NASSCO templates in the first half of 2011, and have been utilizing the NASSCO templates since the first half of 2012.

EPA's review letter dated December 9, 2011 stated that "EPA suggests that Allentown document its CCTV inspections by incorporating the defect ratings in its Geographic Information System (GIS). The GIS should also identify how each defect is addressed."



The City has adopted this approach. The map of Sanitary Sewer Mains CCTV Inspection depicts the pipe segments that were surveyed in the first half of 2015. The map is color coded based on the NASSCO severity rating of the defects in the pipe segment. The resulting problem pipe segments are listed in the *Sanitary Sewer Defects* summary in Appendix A, together with the NASSCO defect classification, type of repair considered, and projected completion date. The repair details of each segment will subsequently be entered into the GIS system.

EPA's review letter dated May 15, 2013 stated that "In its comments regarding the prior semi-annual report, EPA required Allentown to ensure that future semi-annual reports "continue to indicate when and how defects identified will be corrected in addition to providing an updated map detailing the location and type of sewer repairs." In Appendix A, the City has provided a map of sewer repairs carried out, and a table listing identified defects that include the projected date for completion of repairs. In the next progress report, please explain why very little repair work has been carried out on sewers located in riparian zones. In addition, Allentown should indicate whether the table listing yet-to-be-completed sewer repairs includes all identified NASSCO-graded defects. If it does not, Allentown should provide an all-inclusive table that explains why each graded defect not being repaired is not being addressed."

As described in the Progress Report for Period 9, in the past, the sanitary sewer CCTV survey program was for the most prioritized based on the City's Streets Department repaving program. To ensure that the streets being resurfaced would not require excavation resulting from a sewer defect soon after being renewed, all sanitary sewers in the streets to be repaved were televised. However, since few City streets are located in riparian zones, this method of prioritization resulted in few riparian zone sewer defects being identified. In the future, the sanitary sewer CCTV survey program will continue to be coordinated with the repaving program as a requirement of the lease agreement, however it will equally focus on areas that have been identified as exhibiting significant levels of RDII through the flow monitoring and modeling that was completed for the collection system.

As described in the Progress Report for Period 11, in the second half of 2014, the Sanitary Sewer Evaluation Study (SSES) in the primary and secondary basins was completed. The scope of work for the SSES includes CCTV inspection of 102,210 linear feet of sewer, ranging in size from 8 to 36 inches; inspection of approximately 550 manholes; sewer piping point repairs; joint repairs, smoke testing; and heavy cleaning.



The sanitary sewer defects table included in Appendix A of this Progress Report is now all inclusive of NASSCO-graded defects. As previously mentioned in this report, historically, the City had relied on the experience and judgment of an in-house Utility Engineer with more than 50 years of experience to determine when a defect is of sufficient magnitude to warrant repair, and to determine the appropriate method of repair. Defects significant enough to warrant a repair include broken, crushed or collapsed pipe, or large cracks, especially in the bottom half of the pipe. LCA has continued the utilization of this gentleman's expertise and institutional knowledge of the Allentown System in making decisions to repair defects.

With regard to inspection of existing laterals on private property, EPA's May 15, 2013 review letter stated that "In its comments regarding the prior semi-annual report, EPA requested that the City provide an update on its investigation into its authority to inspect existing laterals on private property. Allentown indicates that it does not believe that it has the authority to inspect laterals on private property without cause; however, it does not provide a clear and definitive opinion regarding this issue. EPA suggests that Allentown should secure a definitive legal opinion regarding its authority to carry out inspections of laterals on private property."

As subsequently stated in the Progress Report for Period 9, "Allentown is in the process of securing a definitive legal opinion regarding its authority to carry out inspections of laterals on private property. Allentown anticipates securing the legal opinion by mid-April and will communicate that response in the next report."

The legal opinion regarding the City's authority to inspect laterals was emailed to EPA's Rebecca Crane on April 30, 2014 and was mailed to EPA's Allison Graham on April 28, 2014. A copy of the legal opinion dated April 23, 2014 was included in Appendix A of AO Progress Report No. 10. In summary, the City's relevant ordinance does not provide the authority to undertake general inspections of laterals unless there is a known problem already occurring.

As described in prior Progress Reports, EPA has readily acknowledged that municipalities often do not have the legal authority to address laterals. In 2001 the EPA Administrator signed a proposed rule for SSOs. Although the proposed rule never made it into the Federal Register, it is instructive in that it sets forth EPA's recognition of the limited legal authority of municipalities to address laterals and identifies the underlying municipal ordinance changes EPA would have been requiring, had the regulation been finalized.



First of all, EPA recognized that municipalities did not necessarily have the legal authority to address laterals:

“Almost all building laterals in a municipal system are privately owned.” [Proposal at 18]

“The customers of a municipal sanitary sewer system typically retain ownership of building laterals.” [Proposal at 23]

“Some portion or the entire length of lateral connections to buildings is generally owned by the building owner.” [Proposal at 23]

“The Agency requests comment on whether the legal authority for controlling I/I should specify controlling I/I from private sources, such as the privately owned portions of building laterals.” [Proposal at 74]

In recognition of the limited authority of municipalities (and, apparently recognizing that the legal authority to address laterals should not apply to existing laterals, but only to new or rehabilitated laterals), EPA was proposing to require a municipal CMOM program to include the legal authority to “ensure proper installation, testing, and inspection of new and rehabilitated sewers, such as new or rehabilitated collector sewers and new or rehabilitated service laterals.” [Proposed section § 122.42(e)(2)(iii)(C), Proposal at 157]. Even under such approach, EPA recognized there may be some inherent legal limitations and, as such, “[t]he agency request[s] comments on ownership issues associated with programs to oversee new sewers and major rehabilitation/report efforts.” [Proposal at 79]

EPA never proceeded with the 2001 rulemaking; never addressed the inherent legal limitations associated with laterals, and never required a municipality to adopt an ordinance to have the ability to address laterals.

EPA’s review letter dated December 9, 2011 stated that “In the next project report, please explain whether Allentown has considered or conducted “lateral to main connection” inspections. As described in the subsequent Progress Report, during the course of its CCTV inspections, the City is able to inspect the lateral connections to the sewer main, and is able to make observations regarding the condition of the lateral, such as “Excessive Clear Flow”. In the future, if “Excessive Clear Flow” is observed from a lateral, the appropriate NASSCO code will be used for documentation and a letter will be sent to the property owner.



EPA's April 26, 2012 review letter stated, "Allentown states that during its CCTV inspections, it is able to inspect the lateral connections to the sewer main and make observations such as "Excessive Clear Flow." In future progress reports provide further details on lateral connections to the sewer main inspections including the date, location, and outcome of these inspections and progress with compliance by the property owner."

As reported in the subsequent Progress Report, based on the CCTV logs presented in Appendix A, excessive clear water flow was not observed during CCTV survey work performed in 2013. However, one instance of this form of inflow was observed during a prior reporting period and was subsequently investigated and repaired. The source of the inflow was located at 2100 Linden Street. The timeline of events for this City owned property is presented below:

- September 28, 2011 - CCTV survey of the 10" sewer on Linden Street identified excessive clear water flow originating from the lateral connection of the City's Park Maintenance Building located at 2100 Linden Street.
- June 11, 2012 - Roto-Rooter was contracted to CCTV survey the lateral with a push camera. At 107 foot mark, where the cast iron and terracotta lateral materials met, a large volume of ground water was found to be entering the lateral. No other leaks were detected due to the amount of water entering the pipe. The decision was made to replace approximately 33 feet of this pipe which would eliminate the terracotta portion of the lateral.
- June 26, 2012 - The City obtained three quotes for the repair of the sanitary lateral.
- July 10, 2012 - Joao & Bradley Construction Co. Inc. completed the replacement of a significant portion of the Park Maintenance Building lateral.

EPA's review letter dated May 15, 2013 stated that "Allentown notes that "during the course of its CCTV inspections, the City is able to inspect the lateral connection to the main sewer and to make observations regarding the condition of the lateral, such as "Excessive Clear Flow." In the future, if "Excessive Clear Flow" is observed from the lateral, the appropriate NASSCO code will be used for documentation and a letter will be sent to the property owner." Has the City observed excessive amounts of clear flow from laterals prior to its adoption of NASSCO-compliant CCTV inspection protocols? If so, were letters sent to the owners of those properties? If not, such letters should be sent out, so long as the video documentation of such inspections still exists." As subsequently stated in the Progress Report for Period 9, "it is



believed that excessive amounts of clear flow from laterals was not observed prior to adoption of the NASSCO-compliant CCTV inspections, likely due to limited CCTV inspection in riparian zones, as further described in the Response to Comment 5. Therefore, letters were not sent to property owners.”

The City recognized that it did not have the expertise or the manpower to effectively locate and mitigate the RDII issues identified through the initial phase of sewer system characterization. Therefore, in March of 2011, City of Allentown issued RFP 2011-16 to secure the services of an independent consulting engineering firm to act as a Program Manager for development of a Rain-Derived Inflow & Infiltration (RDII) Removal Corrective Action Plan (CAP), Phase I: System Characterization & Assessment. Copies of the RFP and Addendum 1 were presented in the Progress Report dated July 28, 2011. Addendum 1 established a mandatory pre-bid meeting date of March 25, 2011 and a closing date for the RFP of April 13, 2011. Addendum 2 answered the questions posed by the consulting engineers regarding the RFP.

The City received eight proposals from consultants and subsequently reviewed, evaluated and ranked the proposals during May 2011. A “short list” of the three highest ranked firms was then created based on the technical merit of their proposals, after which the price proposals were opened, consistent with City protocol. From the short listed firms, Whitman, Requardt & Associates, LLP (WR&A) partnering with Omni Environmental LLC, was selected based on lowest cost. In early June the City began contract negotiations with WR&A. The Mayor of Allentown executed the contract with his signature on July 12, 2011. Presented in Appendix B of prior Progress Reports was a copy of WR&A’s Project Approach and Schedule. As indicated, the anticipated schedule was 14 months, which was based on an assumed start date of June 1st versus the actual kick-off meeting date of August 1, 2011. Therefore, the anticipated completion date was September 2012 rather than July 2012. It is also important to recognize that certain assumptions, as described in the Project Approach, were made to generate the anticipated schedule. Example assumptions include the number of manholes that will need to be surveyed and that the City’s geodatabase can be readily imported into the hydraulic model. Actual conditions encountered could result in a shorter or longer schedule.

The RDII Corrective Action Plan was developed in two phases and is now essentially complete. The first phase was System Characterization and Assessment, the objectives of which



were to (1) enable an in-depth understanding of the collection system response to rainfall events, (2) establish the required reduction in RDII to eliminate SSOs during the design storm, (3) identify the general location of significant RDII sources, and (4) to develop a detailed SSES work plan. In the second phase, the SSES work plan will be implemented and specific improvements to the City's sewerage system will be recommended.

The RDII consultant submitted a draft *System Assessment and Phase 1 Corrective Action Plan Report* to the City for review in September 2012. A meeting was subsequently held to discuss the City's comments. The final *System Assessment and Phase 1 Corrective Action Plan Report* was subsequently prepared and submitted to the City in January 2013.

EPA's January 14, 2014 review letter stated "similar to EPA's request above, provide an update on Phase 2 of the RDII CAP in the next Progress Report. Include information detailing whether Allentown's ongoing work to address infiltration in its System since the issuance of the AO, as well as infiltration elimination projects scheduled throughout 2014, aligns with those basins identified as having significant RDII. Additionally, identify whether and how the specific system improvements identified for Phase 2 of the RDII CAP impact infiltration elimination projects (i.e. CCTV) that Allentown previously had planned throughout 2014. Finally, provide a summary of all remaining projects required to address infiltration throughout Allentown's System."

It was subsequently stated in the Progress Report for Period 9 that in the second half of 2013, the City authorized preparation of a Request for Proposal and specifications for the SSES field work recommended in the Phase 1 RDII Corrective Action Plan. The Request for Proposal and specifications were prepared by Whitman, Requardt and Associates (WR&A) in the second half of 2013. The SSES field work includes: (1) CCTV inspection of 102,210 linear feet of sewer ranging in size from 8 to 36 inches comprising the Primary and Secondary Basins, i.e. the areas within the City identified in the Phase 1 RDII Corrective Action Plan as having the highest RDII values; (2) detailed inspection of 543 manholes in the Primary and Secondary Basins; and (3) contingent bid items to be implemented based on the findings of the CCTV and manhole inspections. The contingent bid items include: (1) heavy cleaning of sewer lines, (2) point repairs/removal of obstructions, (3) sealing and testing of sewer line joints, and (4) smoke testing. The total estimated cost of this field work was approximately \$700,000.



The SSES project was advertised for bids on March 20, 2014 and bids were opened on April 28, 2014. Board approval for the construction phase of the project was given at the May 27, 2014 Meeting. The construction contract was awarded to Video Pipe Services and the Notice to Proceed was issued on June 23, 2014 resulting in a completion date of September 23, 2014 (90 calendar contract). However, the completion schedule could be impacted by the magnitude and nature of contingent bid items implemented, which cannot be accurately predicted in advance of bidding the project. The SSES field work Scope of Work was presented in Appendix B of AO Progress Report No. 10.

During the second half of 2014, the SSES field work was completed, and a draft technical memorandum dated December 12, 2014, was prepared presenting the preliminary findings of the SSES, pending receipt and evaluation of the remaining data collected during the SSES field work. Following receipt of review comments and the remaining data, a revised technical memorandum was prepared and submitted to the City and LCA on January 28, 2015. Based on the identified defects and the estimated RDII removal achievable by repairing specific categories of defects, RDII removal values were developed for each individual basin. The RDII removal for each individual basin was then aggregated to estimate the total RDII removal achievable from repair of all defects identified through the SSES field work.

The RDII removal achievable in the SSES study area was subsequently used to perform additional modeling runs to further evaluate the short-listed alternatives utilizing the future flows developed through the 537 Plan Update. As further described below, the modeling runs and alternatives evaluations also considering three specific conveyance alternatives evaluated by the Western Lehigh Sewerage Partnership (WLSP) and whether the increased capacity needs established through the 537 Plan Update will be addressed by expansion of the KIWWTP or by a direct discharge from LCA's upgraded industrial pretreatment plant. This collaborative effort with LCA and the WLSP is further described below.

In 2014, LCA and COA recognized that solving that long-term wet weather flow issues in their systems would require more extensive measures than originally anticipated, along with the need for additional evaluation to ensure the various plans of the signatories were synergistic (or at least not counterproductive to each other). Working together in the Spring and Summer of 2014, a draft completion schedule (referred to as a Plan of Action) was developed. On May 19,



2014, a signatory-wide collaboration meeting was held to discuss a request for schedule extension. On September 10, 2014, a signatory-wide meeting was held with USEPA and PADEP to review evaluation efforts to date and to support the need for additional time. A joint letter was issued to USEPA requesting an extension of the AO on November 14, 2014. A copy of this letter was presented in Appendix C of the AO Progress Report for Period 11, 12 and 13.

The Final Alternative Analysis was conducted in three rounds (Round 1, Round 2, and Confirming Round) and collaboratively with the LCA/WLSP. Output flow hydrographs from the LCA/WLSP's modeling efforts were transmitted to the COA to ensure that the evaluation and sizing of alternatives developed the COA's portion of the collection system consider the tributary flows resulting from the alternatives being evaluated by the LCA/WLSP. The alternatives being evaluated by the LCA/WSSP which result in varying degrees of flow to the KIWWTP include combinations of I/I removal, conveyance improvements wet-weather storage tanks.

The collaborative effort between the COA and LCA/WLSP continued in the second half of 2015 resulting in completion of the first and second rounds of the Final Alternative Analysis. In addition, the COA's RDII consultant completed the initial draft Phase 2 Corrective Action Plan which was submitted to the City in November 2015. The final Phase 2 Corrective Action Plan Report was submitted to the COA in April 2016. An Executive Summary of the Phase 2 Corrective Action Plan Report is presented in Appendix A.

A meeting was held with EPA and DEP on June 14, 2016 to jointly present the COA's and WLSP's selection of final alternatives, the cost savings and other benefits associated with blending versus flow equalization, and the preliminary schedule for phased implementation of recommended improvements.

As described the AO progress Report for Period 13, the EPA has extended the AO date to December 31, 2017, and leading up to this date, will "identify further extensions which may be warranted to accomplish the requirements of the Order."

As examples of the benefits being derived from the identification and repair of defects, three (3) Inflow and Infiltration Elimination Reports have been prepared by LCA which identify the defect location, the defect identification method, the estimated I&I flow rate, the I&I elimination method, repair cost and flow reduction savings. The three reports follow.



Similarly, as part of the SSES technical memorandum, estimates have been made of the RDII removal that can be achieved in the primary and secondary basins.



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INFLOW & INFILTRATION ELIMINATION REPORT

Location: Hamilton St. from St. Elmo to 20th St

M&E Manholes involved: MH 15-11F to 15-11C

Note: this sewer is near Cedar Creek and below creek level.

Pipe Size: 8"

Pipe Material: Vitrified clay pipe



Identification Method: Routine CCTV sewer line survey

Estimated Infiltration Volume: 300,000 GPD or 109.5 MG year

Assumptions: 8" pipe, slope 0.006 flowing half full-see Picture
Normal dry weather flow is about 2,000 GPD

I&I Eliminate Method: Excavate and replace 295 linear feet of sanitary sewer with PVC pipe.



Project Costs: \$ 70,522.

Flow Reduction Savings:
Pumping cost reduction at KIWWT - 109,500 m gals/yr. x \$0.153/ 1000gals
= \$ 16,754/yr. See Attachment 1.



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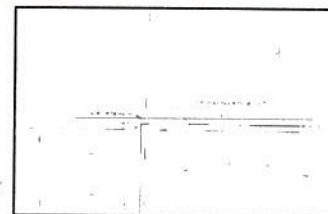
INFLOW & INFILTRATION ELIMINATION REPORT

Location: N. 22nd St. from Pennsylvania to Congress Streets

M&E Manholes involved: MH 18-51E to 18-51F

Pipe Size: 8"

Pipe Material: Vitrified clay pipe



Identification Method: Routine water leak survey

Estimated Infiltration Volume: Estimated volume of infiltration 750,000 GPD or 274 MG year from a 900,000 GPD water leak

Assumptions: Leaks are assumed to remain undetected for about 2 years so total infiltration would be 548 MG

I&I Eliminate Method: I&I eliminated by repair of water main break.



Project Costs: \$1,970

Flow Reduction Savings: Excess pumping costs for the 2 year period were 548,000 m gals x \$0.153/ 1000 gals. = \$ 83,844.



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INFLOW & INFILTRATION ELIMINATION REPORT

Location: Congress St. from N. 22nd to N. 23rd Streets

M&E Manholes involved: MH 18-57G to 18-57H

Pipe Size: 8"

Pipe Material: Vitrified clay pipe



Identification Method: Routine water leak survey

Estimated Infiltration Volume: 1/2 of water leak volume or 1/2 of 122,400 GPD = 61,200 GPD or 22.3 MG yr

Assumptions: Leaks are assumed to remain undetected for about 2 years so total infiltration would be 44.6 MGD

I&I Eliminate Method: I&I eliminated by repair of water line break



Project Costs: \$2,721

Flow Reduction Savings: Excess pumping costs for the 2 year period were 44,600 m gals x \$0.153/ 1000 gals. = \$ 6,824



4.0 Progress Toward System Characterization

As described in the Progress Report for Period 1 dated January 27, 2010, the City initiated a Sanitary Sewer Flow Monitoring program in 2008 to begin the process of identifying the locations and magnitude of infiltration and inflow entering the collection system. The Flow Monitoring program was conducted by ADS Environmental Services and resulted in 90 days of flow data being collected during the period July 31, 2008 through October 31, 2008.

A total of 169 open-channel flow meters and 14 rain gauges were utilized to collect both dry and wet day data and to evaluate performance of the collection system throughout this period. The strategy for meter placement was to create sewer sheds (or basins) upstream of each meter. The final meter layout resulted in an average basin size of 12,230 linear feet (LF) of public sewer.

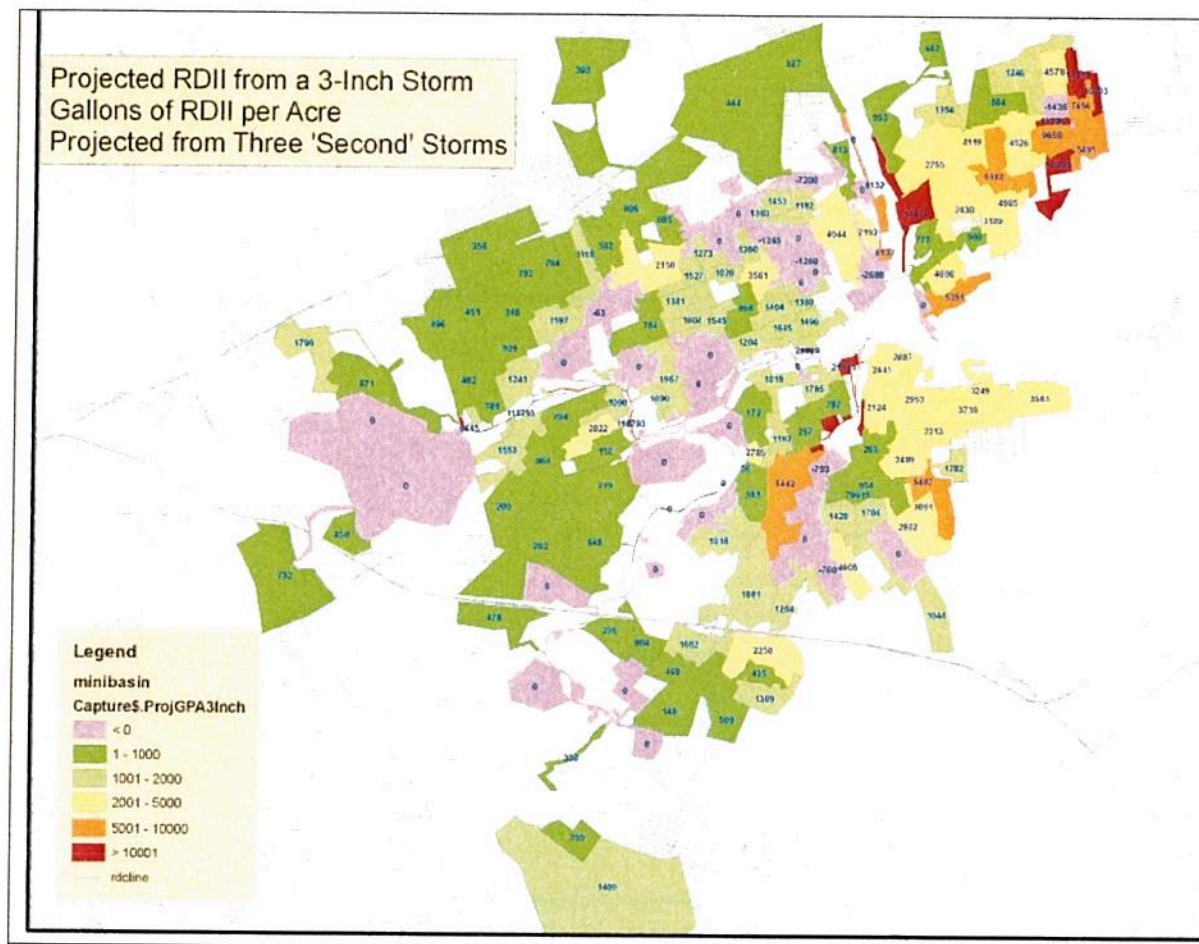
Dry day diurnal flows were subtracted from wet day diurnal flows to calculate RDII. Base infiltration (BI) was also estimated. RDII was defined in the study as flow appearing in sewers during and immediately after a rainfall while BI was defined as the groundwater entering the system on a steady or seasonal basis. The normalized RDII for each basin was calculated by dividing the RDII by the area of the corresponding basin, resulting in Gallons of RDII per Acre.

Figure 1 on the following page is from the ADS report and presents for each basin the normalized RDII resulting from a 3-inch storm. The basins with the highest normalized RDII values indicate areas within the City that will be prioritized in terms of RDII source identification and remediation. A complete copy of ADS' report entitled *City of Allentown Sanitary Sewer System Flow Monitoring Report* dated April 2009 is presented in Appendix B of the Progress Report for Period 1 dated January 27, 2010. The appendices described in the ADS report are included in Appendix B of the Progress Report for Period 1 as electronic files on CD rather than paper copies due to their size.

Based on the findings presented in ADS' April 2009 Report, targeted flow monitoring was conducted in ten (10) of the basins to locate RDII in smaller geographic areas. The targeted metering was conducted with eighteen (18) ADS flow meters owned by the City during the period April 2009 through June 2009. RDII was expressed in gallons per day per LF of collection system per inch average of all storms.



Figure 1



The RDII values from the Target Flow Monitoring program are presented in Figures 2, 3 and 4, and are from the ADS report entitled *City of Allentown Sanitary Sewer System Flow Monitoring Report, Target Monitoring #1* dated August 28, 2009. A copy of this report is presented in Appendix B of the Progress Report for Period 1 dated January 27, 2010. The appendices described in the ADS report are included in Appendix B of the Progress Report for Period 1 as electronic files on CD rather than paper copies due to their size.

The information generated from Target Flow Monitoring further refines the location of areas to be prioritized for RDII source identification and remediation. The first such area that the City has selected for detailed investigation is Midway Manor, which is part of the SSES field work described in previous section of this report. The SSES field work was performed in 2014.

Allentown Target Metering
April to June 2009
RDII - Gallons per LF per Inch
Average of All Storms

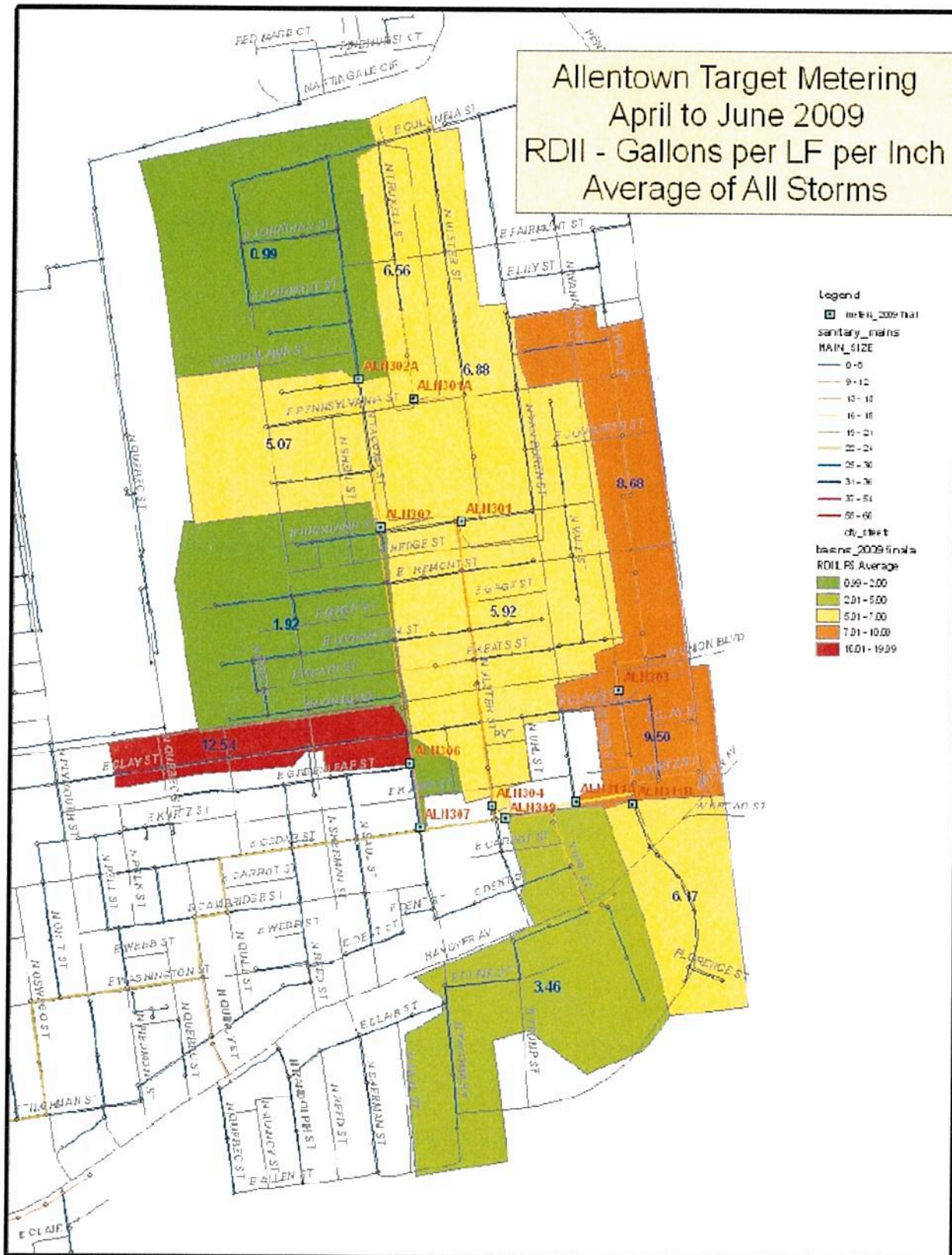




Figure 3

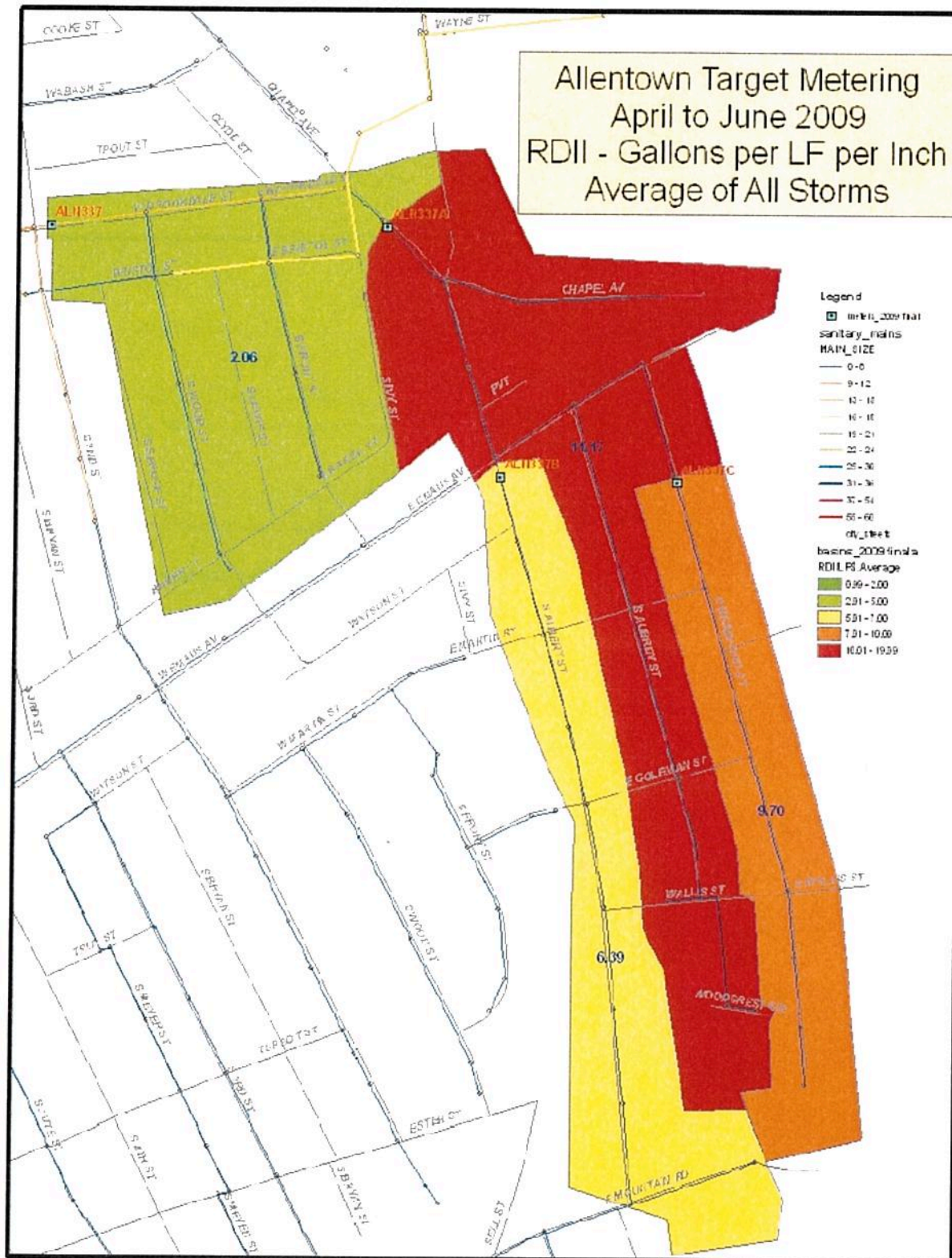
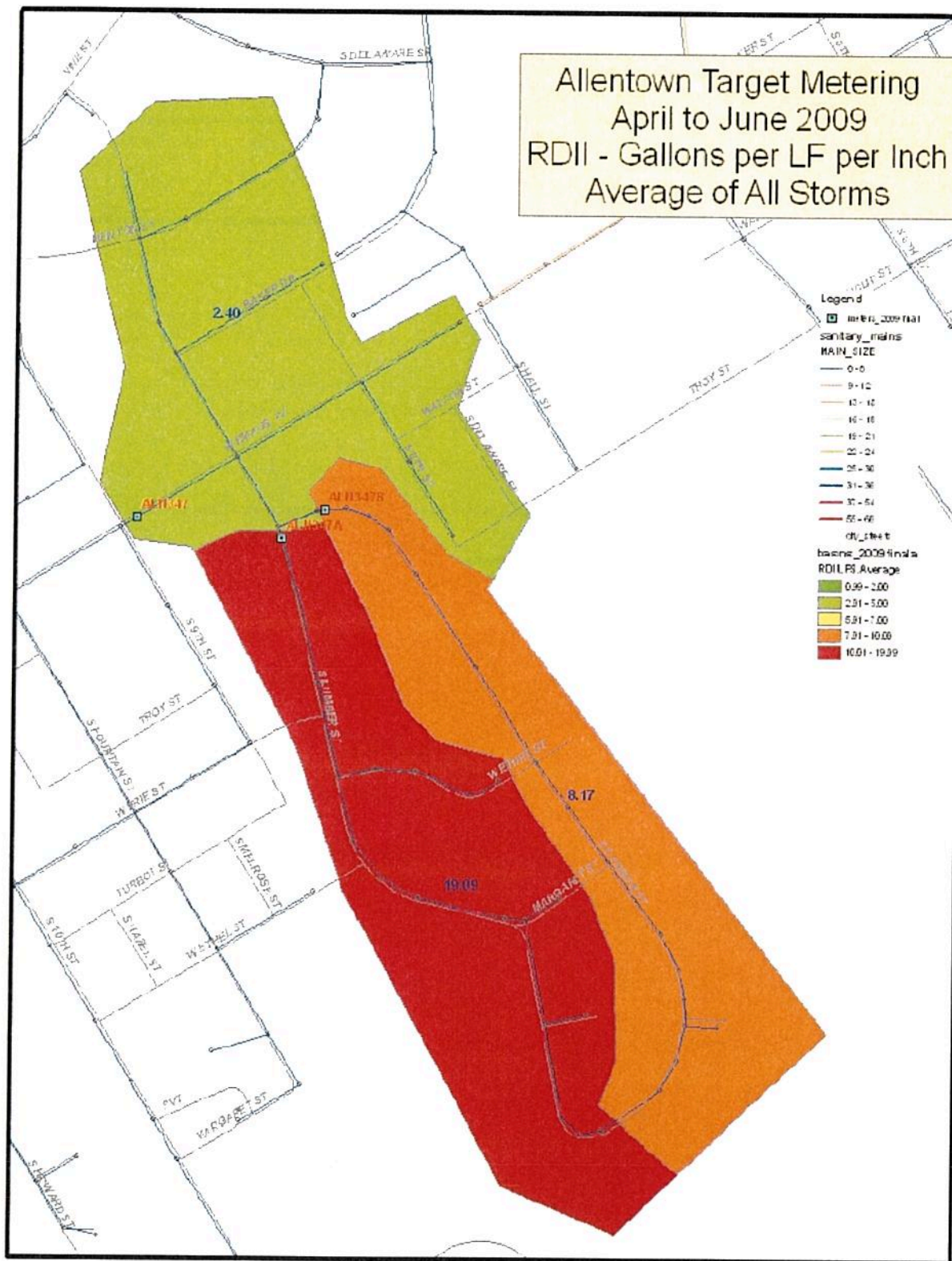




Figure 4





During the flow monitoring program described above, system information was discovered leading to questions about the hydraulic flow pattern in certain locations. This information and the related questions are presented on a series of 8-1/2" x 11" maps in Appendix B of the Progress Report for Period 2 dated July 27, 2010, beginning with the one titled Legend for Maps Showing Questions on Hydraulic Pattern. These questions will be addressed through the RDII consultant's hydraulic modeling of the collection system.

EPA's May 15, 2013 review letter stated "Allentown notes that "during the flow monitoring program described above, system information was discovered leading to questions about the hydraulic flow pattern in certain locations. This information and the related questions are presented on a series of 8-1/2" x 11" maps in Appendix B of the Progress Report for Period 2 dated July 27, 2010, beginning with the one titled Legend for maps showing Questions on Hydraulic Pattern. These questions will be addressed through the RDII consultant's hydraulic modeling of the collection system." Allentown should explain in the next progress report if it plans to confirm by physical investigation any alternative flow routing suggested by its modeling." It was subsequently stated in the Progress Report for Period 9 that based on the confirmation of various manhole invert elevations during modeling and the calibrated and validated modeling results, additional physical investigation is not required.

In 2010, a third round of flow monitoring was performed during the period April 1, 2010 through June 7, 2010. The objective of this study was to re-meter 18 of the locations from the original 2008 flow study and compare the average dry day flow and wet weather flows (peak and volume) for the 2010 storms versus the 2008 storms.

The results of the third round of flow monitoring is presented in a report titled *City of Allentown Flow Monitoring Report for 2010* dated November 2010, a copy of which is in Appendix B of the Progress Report for Period 3 dated January 28, 2011. The key objective of this round of monitoring was to compare measured average dry day flow and Peak RDII, as well as the projected volume of RDII from a 5-year, 3-inch rainfall, based on flow monitoring data collected in 2008 versus 2010. In general, the projected volume of RDII was greater based on 2010 data compared to 2008 data, possibly due to dryer conditions in 2008.

EPA's May 24, 2011 review letter stated, "In the next Progress Report, please explain how Allentown plans to utilize the results of the third round of flow monitoring data and, based on these results, if I&I elimination is anticipated for additional basins." It was subsequently



reported that the RDII Program Manager will utilize the results of all flow monitoring, including the third round, together with development and calibration of a hydraulic model, simulation of additional wet weather events, and review of other information and data, to develop a detailed SSES work plan that will be prioritized on a basin by basin basis. Implementation of the SSES work plan will provide the data needed to conclude in which basins I&I elimination is anticipated.

EPA's December 9, 2011 review letter stated that "The RDII consultant's work is anticipated to last over one year, with completion of a corrective action plan scheduled for mid-2012. The next two or three Progress Reports should identify additional basins that contribute to the RDII problem, as well as a plan to correct RDII in these basins." It was subsequently reported that implementation of the SSES work plan in Phase 2 of the RDII corrective action plan will enable identification of the basins that contribute most significantly to the RDII problem, and the plan to correct RDII in these basins.

Sanitary Sewer Overflows that occurred on November 23, 2011 and June 1, 2012, together with information from the calibrated hydraulic model, have demonstrated a capacity bottleneck where the Little Lehigh Creek Interceptor joins the Cedar Creek Interceptor. The RDII consultant was directed to provide a proposal for additional flow monitoring to capture significant wet-weather flows in these interceptors. However, the City subsequently decided not to proceed with additional flow monitoring and is comfortable, based on additional modeling under simulated high antecedent moisture conditions, that the calibrated model is accurate.

A draft *System Assessment and Phase 1 Corrective Action Plan Report* was submitted to the City for review in September 2012. The draft report presented various options for addressing capacity bottlenecks and SSO's. A meeting was subsequently held to discuss the draft report, and the RDII consultant subsequently finalized the report and submitted it to the City in January 2013. The Executive Summary of the Phase 1 Corrective Action Plan Report was presented in Appendix B of AO Progress Report No. 10. A complete copy of the report is available upon request.

As indicated in the previous sections of this Progress Report, in the second half of 2013, the City authorized preparation of a Request for Proposal and specifications for the SSES field work recommended in the Phase 1 RDII Corrective Action Plan. The Request for Proposal and specifications were prepared by Whitman, Requardt and Associates (WR&A) in the second half



of 2013. The SSES field work includes: (1) CCTV inspection of 102,210 linear feet of sewer ranging in size from 8 to 36 inches comprising the Primary and Secondary Basins, i.e. the areas within the City identified in the Phase 1 RDII Corrective Action Plan as having the highest RDII values; (2) detailed inspection of 543 manholes in the Primary and Secondary Basins; and (3) contingent bid items to be implemented based on the findings of the CCTV and manhole inspections. The contingent bid items include: (1) heavy cleaning of sewer lines, (2) point repairs/removal of obstructions, (3) sealing and testing of sewer line joints, and (4) smoke testing. The total estimated cost of this field work was approximately \$700,000.

The SSES project was advertised for bids on March 20, 2014 and bids were opened on April 28, 2014. Board approval for the construction phase of the project was given at the May 27, 2014 Meeting. The construction contract was awarded to Video Pipe Services and the Notice to Proceed was issued on June 23, 2014 resulting in completion date of September 23, 2014 (90 calendar contract). However, the completion schedule could be impacted by the magnitude and nature of contingent bid items implemented, which cannot be accurately predicted in advance of bidding the project. The SSES field work Scope of Work was presented in Appendix B of AO Progress Report No. 10.

During the second half of 2014, the SSES field work was completed, and a draft technical memorandum dated December 12, 2014 was prepared presenting the preliminary findings of the SSES, pending receipt and evaluation of the remaining data collected during the SSES field work. Following receipt of review comments and the remaining data, a revised technical memorandum was prepared and submitted to the City and LCA on January 28, 2015. Based on the identified defects and the estimated RDII removal achievable by repairing specific categories of defects, RDII removal values were developed for each individual basin. The RDII removal for each individual basin was then aggregated to estimate the total RDII removal achievable from repair of all defects identified through the SSES field work.

As previously described in this Progress Report, the RDII removal achievable in the SSES study area was used to in the additional modeling runs for the Final Alternatives Analysis. As also previously indicated in this Progress Report, the Final Alternative Analysis was conducted in three rounds (Round 1, Round 2, and Confirming Round) and collaboratively with the LCA/WLSP. Output flow hydrographs from the LCA/WLSP's modeling efforts were transmitted to the COA to ensure that the evaluation and sizing of alternatives developed the



COA's portion of the collection system consider the tributary flows resulting from the alternatives being evaluated by the LCA/WLSP. The alternatives evaluated by the LCA/WSSP that resulted in varying degrees of flow to the KIWWTP included combinations of I/I removal, conveyance improvements, and wet-weather storage tanks.

The collaborative effort between the COA and LCA/WLSP continued in the second half of 2015 resulting in completion of the first and second rounds of the Final Alternative Analysis. In addition, the COA's RDII consultant completed the initial draft Phase 2 Corrective Action Plan which was submitted to the City in November 2015.

In the first half of 2016, the final Phase 2 Corrective Action Plan Report was submitted to the COA in April 2016. An Executive Summary of the Phase 2 Corrective Action Plan Report is presented in Appendix A. In addition, a meeting was held with EPA and DEP on June 14, 2016 to jointly present the COA's and WLSP's selection of final alternatives, the cost savings and other benefits associated with blending versus flow equalization, and the preliminary schedule for phased implementation of recommended improvements.

To enable this schedule to be implemented, and as previously described, the EPA has extended the AO December 31, 2017, and leading up to this date, will "identify further extensions which may be warranted to accomplish the requirements of the Order."

A detailed map of the existing sanitary sewer mains is presented in Appendix B of the Progress Report for Period 2 dated July 27, 2010. An area map showing the location of the primary and secondary basins is presented on the following page.

EPA's review letter dated January 14, 2014 stated "Allentown's future Progress Reports should continue to include a response to all information required in Paragraph 22.c. of the AO."

As stated in the Progress Report for Period 9, the City will continue to comply with this requirement.

The AO Summary Report submitted to EPA in the second half of 2014 includes a detailed summary of system characterization efforts. A copy of the AO Summary Report is presented in Appendix B.

